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Design Specifications For An Electric Meter Interface

For StatSIGNAL Systems, Inc.

Revisions

1. First Draft - February 17, 2000 rcs
2. Second Draft - June 11, 2000 rcs Corrected after reviews
3. Revised Second Draft - July 05, 2000 - PDM: Corrected after internal review.
4. Revised Second Draft - July 14, 2000 - PDM: Deleted all references to a "LowBat" condition.

Design Specifications
Electric Meter Interface
July 14, 2000

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Confidential Document

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1. Scope

This design specification is provided to StatSIGNAL Systems, Inc., for an interface to an electric meter for automatic meter reading. It is part of a family of equipment for utilization at sites where automatic meter reading and safety system features may be incorporated.

2. Unit Description

The Model 100 Electric Meter Interface shall be a system comprised of a single Atmel microprocessor, an optical interface to the electric meter's wheel, and a power supply. The Electric Meter Interface shall accumulate, and, on command, transmit the total electric meter ticks directly (or indirectly) to a Site Controller. The user is generally a utility who dispenses electric power to homes or physical plants.

3. Definitions

ANSI - American National Standards Institute - An organization which promulgates standards on various technical topics.

ASCII - American Standard Code for Information Interchange

ASME - American Society of Mechanical Engineers
international

Battery Back Up Function - Provides power for operation of a piece of equipment in the absence of AC Mains by use of a Secondary Battery or some other energy storage device such as a super cap.

CCITT - Comite Consultatif Internationale de Telegraphique et Telephonique (Consultative Committee on International Telephone and Telegraphy). Recently renamed the ITU-T. An organization which promulgates various standards for telephony including modems and facsimile.

CFR - Code of Federal Regulations

CFR Title 47 - The Section of the Code of Federal

Regulations which is promulgated by the FCC.

Classified Location - A location designated by NFPA Codes as being a hazardous location because of danger of explosion.

CRC - Cyclic Redundancy Check Sum - A number which is the remainder of dividing (modulo two division) the message as a large number by the generating polynomial. This check sum is used to detect transmission errors in communications links in order to request a transmission be repeated until received correctly.

EIA - Electronic Industries Alliance - An organization composed of various manufacturers and developers of electronic equipment which, as a part of its function, promulgates standards on various topics. Most notable of the standards is ANSI/TIA/EIA-232-D, the electrical interface for modems.

ETL - ETL SEMKO, a division of Intertek Testing Services, a company which provides recognized third party testing services to UL and NFPA standards and Lists products as conforming to those standards and usable in the application for which it is Listed. ETL does not promulgate standards such as UL does.

FCC - Federal Communications Commission.

IEC - Commission Electrotechnique Internationale (International Electrotechnical Commission) An international standards promulgating committee which publishes standards on various electrical, information technology and mechanical subjects.

IEEE - Institute of Electrical and Electronic Engineers, Inc., a professional organization which also promulgates standards used in industry.

Intentional Radiator - An electronic system which intentionally (by design) radiates radio frequency energy in order to perform its functions.

Installation Maintenance System - A system operating on a small personal computer and using a RF

transmitter/receiver which verifies and maps RF communication between devices and provides said information to an Internet Service Provider.

ISA - Instrument Society of America, an international society for instrumentation and control.

ITU-T - International Telecommunication Union - Telecommunications (nee CCITT, see above).

NEC - National Electrical Code (NFPA 70, 1999).

NFPA - National Fire Protection Association. This organization is a publisher of safety codes which are used by UL in the generation of their standards and are passed as having the force of law by various local jurisdictions.

Primary Battery - A battery which is not rechargeable and is generally the primary source of power for some circuit.

Repeater or Repeater Function - A piece of equipment which may operate as a radio frequency repeater receiving a transmission from one device and passing it to a second device by transmitting the message, or some slightly changed version thereof, again.

Safety System - A system wherein alarms from remote devices indicate danger to life and/or property which must be immediately reported as required by NFPA 72.

Secondary Battery - A battery which is rechargeable. As the battery is charged, an external power source is available making the Secondary Battery the secondary source of power for a circuit.

Site Controller - A small, outdoor unit with battery backup for operation without power which provides communications with the devices assigned to it and transmitting necessary data via the internet protocol to and from a central processing system.

Test System - A system used only in the factory to test components (i.e., printed circuit boards) for the RF Transceiver, Electric Meter Interface, Smoke

Detector Communication Device, and Personal Security Device (FOB).

TIA - Telecommunications Industry Association - A part of EIA.

UL - Underwriters Laboratories, Inc., a non-profit organization which publishes safety standards for equipment and tests and Lists such equipment which meets those standards.

Unintentional Radiator - An electronic system which unintentionally radiates radio frequency energy as a result of the use of digital design techniques in order to perform its functions.

4. Trademark Registrations

ASME - The registered Trademark representing the American Society of Mechanical Engineers International

Atmel - The registered Trademark representing Atmel Corporation

AVR - A registered Trademark for a family of small micro processors owned by Atmel Corporation

ETL - A registered Trademark owned by Intertek Testing Services (also a Listing Mark)

IEEE - The registered Trademark representing the Institute of Electrical and Electronic Engineer, Inc.

ISA - The registered Trademark representing the Instrument Society of America

Motorola - A registered Trademark representing Motorola, Inc.

NFPA - The registered Trademark representing the National Fire Protection Association

RF Monolithics - The registered Trademark representing RF Monolithics, Inc.

UL - The registered Trademark representing Underwriters Laboratories, Inc. (also a Listing Mark)

5. Applicable Regulatory and Other Agency Documents and Standards

CFR Title 47, Part 15, Subpart B (for Unintentional Radiators)

CFR Title 47, Part 15, Subpart C (for Intentional Radiators)
 CFR Title 47, Part 68 (Requirements for Telephony Equipment
 connecting to the Public Telephone Network)
 IEC 61000-4 Parts 2, 3, and 4 (International Standards for
 Electromagnetic Compatibility)
 IEEE C62.36 (Standards for Lightning and Impulse Noise
 Protection for Communications Lines)
 IEEE C62.41 (Standards for Lightning and Impulse Noise
 Protection for AC Mains Connections)
 NEC - National Electrical Code (see NFPA 70)
 NFPA 70, 1999 (Latest Edition of the National Electrical
 Code (NEC))
 NFPA 72, 1999 (Latest Edition of Nation Fire Alarm Code)
 UL 50 - Enclosures for Electrical Equipment
 UL 294 - The Standard for Access Control System Units
 UL 365 - The Standard for Police Station Connected Burglar
 Alarm Units and Systems
 UL 603 - Standard for Power Supplies for use with Burglar
 Alarm Systems
 UL 609 - The Standard for Local Burglar-Alarm Units and
 Systems
 UL 611 - The Standard for Central-Station Burglar-Alarm
 Systems
 UL 636 - The Standard for Holdup Alarm Units and Systems
 UL 639 - The Standard for Intrusion-Detection Units
 UL 681 - Standard for Installation and Classification of
 Burglar and Holdup Alarm Systems
 UL 827 - Standard for Central-Stations for Watchman,
 Fire-Alarm and Supervisory Services
 UL 1023 - The Standard for Household Burglar-Alarm System
 Units
 UL 1037 - The Standard for Antitheft Alarms and Devices
 UL 1076 - The Standard for Proprietary Burglar Alarm Units
 and Systems
 UL 1610 - The Standard for Central-Station Burglar-Alarm
 Units
 UL 1635 - The Standard for Digital Alarm Communicator System
 Units
 UL 1641 - The Standard for Installation and Classification
 of Residential Burglar Alarm Systems
 UL 1950 - Safety of Information Technology Equipment
 Including Electrical Business Equipment.
 UL 1981 - Central Station Automation Systems

6. Applicable StatSIGNAL Systems Documents

- 9000074 - Design Specifications for an Electric Meter Interface
- 9000075 - SOS OEA Packet Message Protocol (RF)
- 9000076 - Design Specifications for a Repeater Function Installed in Stand Alone Devices or Other Devices
- 9000077 - Design Specifications for a Smoke Detector Communications Device
- 9000078 - Design Specifications for a Personal Security Device (FOB)
- 9000079 - Design Specifications for a Meter and Security System Site Controller
- 9000080 - Design Specifications for a Multiple Water Meter Interface
- 9000081 - Design Specifications for an Individual Natural Gas Meter Interface
- 9000082 - Design Specifications for an RF Connected, Multiple Security Device Interface (Translator)
- 9000083 - Design Specifications for a Land Line Connected, Single Point Site Controller
- 9000084 - Design Specifications for a Light Detection Device
- 9000085 - Design Specifications for a Vending Machine Interface
- 9000086 - Design Specifications for an Individual Water Meter Interface
- 9000087 - Design Specifications for an Installation Maintenance System
- 9000088 - Design Specifications for a Test System

7. Electric Meter Interface Detailed Description

7.1 Microprocessor

The Electric Meter Interface shall use the Atmel AT90S8515 microprocessor, an embedded controller. It shall use a "Capacitor Holdup" of 50 milliseconds in case of main power failure.

7.2 Data to be Stored

7.1.1 Program

The program shall be stored in flash memory which is loaded by the Test System or, if need arises, by the Installation Maintenance System.

7.1.2 Device Address and Identification

The Device Address and Identification string of six bytes shall be stored in EEPROM. This string shall be assigned at time of production or installation in accordance with the Device Address and Identification Specification.

7.1.3 Totalizer

Five Bytes of binary coded decimal data (ten digits) which is the total number of ticks (rotations of the meter wheel) from some assigned starting number. The assigned starting number may be loaded at the time of installation. It is zero when the unit is manufactured.

The totalizer (five bytes) is kept in RAM until a main power failure condition is noted. At that time, it is loaded into EEPROM and the unit ceases operation until the power fail condition returns to normal.

7.1.4 Ticks

TBA

7.2 Communication With Repeater (or Site Controller)

The Electric Meter Interface shall communicate with a Repeater (or Site Controller) via an RF Link described in the following paragraphs:

7.2.1 Radio Frequency Communications

The Electric Meter Interface shall use a an RF Monolithics TR1000 radio link (half duplex) operating at a radio frequency bit speed of 4,800 bits per second and a data bit speed of 2,400 bits per second with Manchester Encoding. The Electric Meter Interface shall conform to the requirements of SOS OEA Packet Message Protocol (RF), Document number 9000075, in all respects.

7.2.2 Antenna

The Electric Meter Interface shall use a printed circuit board mounted antenna described in RF Monolithics' documentation (tr1000o.vp).

7.4 Communication With Test System

Communication with the Test System shall be via a hardware link described in Atmel Documentation as a serial programming link. (See appropriate Atmel Documentation such as Atmel Document 0839E.)

7.5 Communication With Installation Maintenance System

Communication with the Installation Maintenance System shall also be via a hardware link described in Atmel Documentation as a serial programming link. (See appropriate Atmel Documentation such as Atmel Document 0839E.)

7.6 Operation Described

The Electric Meter Interface shall perform the following operations:

7.6.1 Count Meter Ticks

The Electric Meter Interface shall count and totalize meter ticks and store that total in RAM (or in EEPROM in the case of loss of AC power) for later recovery.

The Electric Meter Interface assumes any passing of the meter wheel sensing point to

be the use of power. No provision is made for the load side of the meter to provide power to the AC Mains grid (meter running backwards). Each detection of the passing of the meter sense point is assumed to be consumption of power by the load side.

7.6.2 Message Transmission

The Electric Meter Interface (using the RF Monolithics radio link defined in paragraph 7.3.1 above) shall not transmit any data unless it receives a command to do so. Message acknowledgement shall be in accordance with SOS OEA Packet Protocol (RF), Document number 9000075. Should the acknowledgement not be received in a timely manner, the Electric Meter Interface shall retransmit the response. The Electric Meter Interface's time out value shall be the value of the fixed time out below.

7.6.3 Fixed Time Out

A unit, when expecting an acknowledgement of one of its messages, shall begin to receive the preamble of that message in less than twenty-five (25) milliseconds before considering the unit to which the message has been sent as unresponsive.

This time out shall be reset (begin again) and have a value of one second should another unit seize the channel before a response can be received.

Should a unit have message traffic to send and should it hear and correctly decode an emergency message of any type, it shall discard and not send its current message traffic.

7.6.4 Random Time Out

Where the protocol calls for a Random Time Out to be generated, that time shall be the

value (in milliseconds) of a free running counter read when required.

7.6.5 Retries and Retry Byte

The Electric Meter Interface shall utilize a retry counter to count (record) the number of retries for message transmission.

The retry counter shall reset after it has been reported and acknowledged.

The Electric Meter Interface shall attempt an original transmission and six retries. If the message is not acknowledged during this cycle, it will abort the current operation and not reset its retry counter.

The Retry Byte shall consist of the value of the retry counter bit 7 being the most significant and bit 0 least.

7.6.6 Ticks

TBA

7.6.7 Power Supply

The power supply for the Electric Meter Interface shall consist of one stage. That stage shall be driven via a 240 VAC transformer which shall provide a 3.5 to 8 volts head after being full wave rectified and filtered. This head voltage shall be regulated by a series pass regulator to a level of 3.3 volts. The head voltage shall charge a capacitor (to provide processing time in the case of AC Mains failure). A Schottky rectifier diode shall prevent reverse current flow in the absence of AC Mains.

The capacitor shall provide sufficient power to write the value of the Totalizer into EEPROM before operations must cease.

8. Target Cost and Quantity

In quantities of 1,000,000 per year, the Unit cost to manufacture an Electric Meter Interface shall not exceed \$30.00. This cost does not include installation in a meter housing.

9. Meter Installation Design

The Electric Meter Interface shall be designed to be installed in a meter Model xxxx, manufactured by xxxxxx (model and manufacturer to be determined). Printed Circuit board and mounting shall be designed for that model only.

10. Application of UL Standards and NEC

The Electric Meter Interface, when installed, shall conform to the requirements of UL 50 and UL 414 as well as NFPA 70 (NEC). In referring to UL 414, the design and installation of the Electric Meter Interface shall in no manner cause the Meter Socket to not conform to that Standard. Such conformance of UL Standards shall be judged by a third party testing firm such as UL or ETL. A third party testing firm shall also judge conformance with NFPA 70 although the final approval for each installation shall rest with "the authority having jurisdiction" as defined in NFPA 70.

11. Capability of Acting as a Repeater

The Electric Meter Interface cannot, and shall not, act as a repeater for emergency message traffic of any type.

12. Environmental Requirements

The fully packaged Electric Meter Interface shall operate correctly in all respects in the following environments:

12.1 Temperature and Humidity

The Electric Meter Interface shall operate from -40°C to +55°C in direct sunlight (10,000 foot lamberts) at all humidities from 0 to 100 percent relative and condensing.

12.2 Electrical

12.2.1 Electro-Static Discharge

The Electric Meter Interface shall continue to operate correctly during repeated electro-static discharges of all voltage levels from 1,000 to 25,000 volts at 0.1 joules maximum energy for air discharge and 1,000 to 8,000 volts at 0.1 joules maximum energy for direct contact discharge.

12.2.2 Radiated Noise

The Electric Meter Interface shall continue to operate correctly under both horizontally and vertically polarized, specific frequency, radiated electric fields of 200 volts per meter from a frequency of 10,000 Hz to at least 1 Ghz.

12.2.3 AC Mains

When connected to the AC Mains, the Electric Meter Interface shall continue to operate correctly under the appropriate maximum conducted electrical noise levels specified by IEEE Standard C62.41 and IEC Standard 61000-4, Level 3.

13. Agency Approvals and Conformance to Operational Standards

In addition to the UL Standards and NFPA Codes mentioned above, the Electric Meter Interface shall be "Verified" by its manufacturer to conform to the requirements of CFR Title 47, Part 15, Subpart B (for Unintentional Radiators) as a Class A Digital Device. The Electric Meter Interface shall be "Certificated" by the FCC as conforming to the requirements of CFR Title 47, Part 15, Subpart C (for Intentional Radiators). The terms "Verified," "Manufacturer's Verification," and "Certificated" are used as defined in CFR Title 47, Part 15.

14. Connection to Other Equipment

The connection of other equipment to the Electric Meter Interface is not permitted under any circumstances unless such connection is described in this Specification.

15. Life and Failure Rate

The Electric Meter Interface shall be designed for a field return rate of one-half of one percent or less annually for the first 10 years of use. This failure rate does not include mistreatment or vandalism.

16. Firmware

The firmware for the microprocessor utilized by the Electric Meter Interface shall be written in assembly language.

17. Commands

The Electric Meter Interface shall respond to the following commands:

17.1 Read Status (0x10)

This command, when received by the Electric Meter Interface, shall be construed as "read totals and status". Six bytes (five totals bytes and one status byte) shall be sent in response to the command. The five totals bytes shall consist of binary encoded decimal numbers which represent the ten digits of the current totalizer reading (most significant byte first). The status byte shall be the value of the retry counter.

17.2 Ticks

TBA